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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and conventional laboratories. This teaching guide, designed to be read in conjunction with the related student guide, includes instructional strategies, lists of required materials, laboratory procedures, and other information for activities, experiments, and field studies in a two-part unit in which students investigate: (1) the solar system; (2) structure and formation of the earth; (3) igneous, metamorphic, and sedimentary rocks; and (4) the nature and formation of soils. Characteristics of the major soil types found in Zimbabwe, the trees characteristically associated with these soils, and soil conservation are stressed. Each section in this guide corresponds to a given section in the student study guide. (JN)

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STUDY GUIDE UNIT F1

Our Planet Earth

UNIVERSITY OF ZIMBABWE
AND MINISTRY OF EDUCATION AND CULTURE

SE 043 845

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ZIM-SCI

ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

GENERAL SCIENCE

STUDENTS: Please read this carefully. It will help you.

How you will study

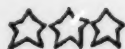
This Study Guide comes to you with a kit of apparatus. Both things are part of a study programme leading you to an understanding of aspects of science. In this course you will be carrying out experiments. The Study Guide will help you to understand the scientific principles behind the experiments.

Your work should be done as you are instructed, either by the teacher or the Study Guide.

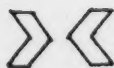
To help you to see quickly what you must do, the Study Guide uses these symbols:



for "Read and revise your notes and Study Guide"



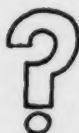
for "Take note of an important point that you should learn"



for "Summary. This is to help you to go over what you have learned"



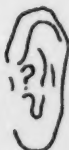
for "Experiment"
When you see this sign,
read the instructions
carefully from beginning
to end before you start
to do the experiment.



for "How much do you know?"
This is for you, to help
you to test whether you
are remembering what is
important.



for "Written work"
This is when you must
answer questions in
writing.



for "Listen to the teacher
and do exactly what
the teacher tells you
to do"



for "Activity"
This symbol will appear
whenever you are asked
to do something without
your apparatus.

UNIT F1 : OUR PLANET : EARTH

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AIMS OF THIS UNIT

When you have completed this study unit you will be able to:

1. Describe the probable origin and structure of the earth.
2. Describe the general characteristics of igneous, metamorphic and sedimentary rocks.
3. Identify some rock specimens from their appearance.
4. Explain how soil is formed.
5. Demonstrate that soils are composed of solid particles of varying size.
6. Describe the general characteristics of clay, sand and humus and relate them to rock types.
7. Identify the clay/sand/humus proportion in a particular soil.
8. Relate soil characteristics to an ability to hold water.
9. Relate soil characteristics to fertility and agricultural use.
10. Identify some of the characteristic trees related to particular soil types.
11. Classify a particular soil in terms of its vegetation.
12. State reasons why soil conservation is important.

UNIT F1OUR PLANET : EARTHPART ISTRUCTURE OF THE EARTH

In Units F1 and F2, you are going to find out more about the earth. You will learn about the elements that make up the earth and how they combine to form many compounds. This Unit (F1) explains how the earth first began and why it looks as it does today.

ACTIVITY 1

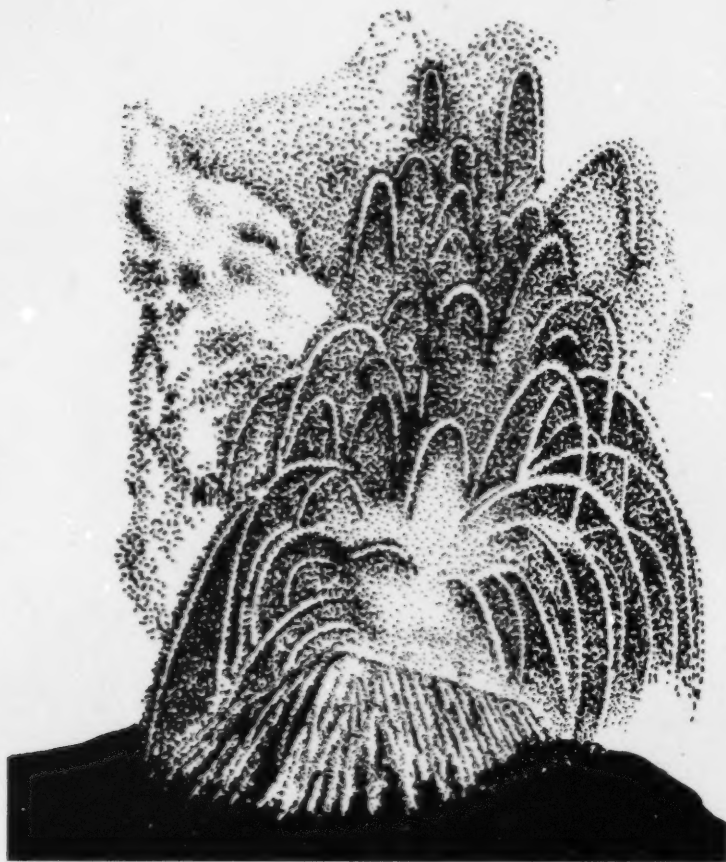
Before you start to read about how the earth began, go outside and listen to your teacher.

When you return to the classroom, answer Exercise 1.



When you looked at the earth under your feet, all that you were able to see was the top of the soil. Perhaps a few small rocks were sticking up. Is the whole world made of soil? What happens if you dig deep down? That is right - the soil gets harder and harder and eventually becomes very hard rock. It is possible to get through some of this rock if we use a drilling machine. What would we find if we drilled deeper and deeper, far down into the earth? Much deeper than the deepest mine where men dig for gold?

Of course, man has never been that far down into the earth, but we can make some guesses about what would be found there. We know from measurements of temperature made at the bottom of deep mines that it gets hotter and hotter as you go down. We also know that certain mountains on earth sometimes send out flames, gases and dust. We call these mountains VOLCANOES. You will learn more about volcanoes later.



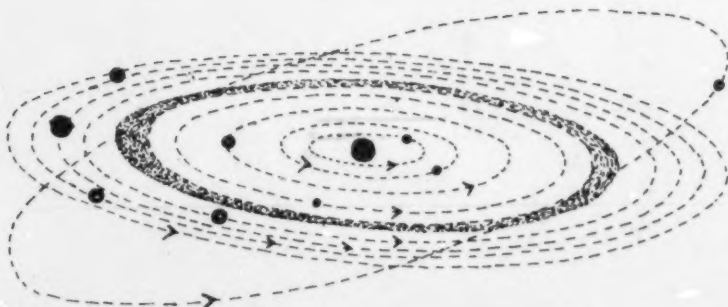
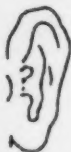
The top of a volcano

Flames and gases are coming from deep inside the mountain

Pieces of evidence which help us to solve problems are called **CLUES**. From the clues about temperature and volcanoes we believe that the centre of the earth is very, very hot - much hotter than anything you have ever known. How did it get like that?

To answer that question, we have to go back in time, millions and millions of years. It is very hard to think of a million years, isn't it? It is too long a time for anyone to imagine very well, so don't worry if you find it difficult! We do have a few clues to help us decide what happened, all that long time ago.

If you look up into the sky at night, you will see some 'stars' which seem much brighter than most of the others. These are called **PLANETS** and, like the earth, they all go around the sun. There are nine planets altogether including Earth, and these nine planets make up what is called the **SOLAR SYSTEM**. Perhaps you have learned about this before, in geography? Your teacher will discuss this with you.



The planets of the solar system
(not to scale)

It is important to notice that all the planets go round the sun in the same direction. Most of them also rotate (spin) like the earth. Because of these clues, we believe that the planets all started to form at the same time. They are all about the SAME AGE.

No one knows whether the sun formed at this time too. What does seem likely is that the whole thing started out as a great big cloud of very hot GAS and DUST. This hot cloud started to cool down slowly and the gases became drops of liquid. The liquid was not like any of the ones you have used in your experiments - it was liquid rock! So you can see that the cloud was still very, very hot. As it went on cooling, the drops of liquid began to form the planets.

So the earth began as a cooling ball of flaming gases and dust. This is hard to imagine too, so you will now set up an experiment to help you to imagine it. This experiment is NOT a model, because we cannot possibly make a model which is good enough. All it will do is help you think of a flaming ball.

EXPERIMENT 1 : To make a flaming ball

You will need:

your burner stand	)	
evaporating dish	)	from your basic kit
matches	)	
spatula	)	
a square of aluminium foil	)	
3 spatulas potassium nitrate		
2 spatulas sulphur		
3 spatulas ammonium dichromate		
1½ pieces of filter paper		
5ml methylated spirits		
a strip of steel wool		



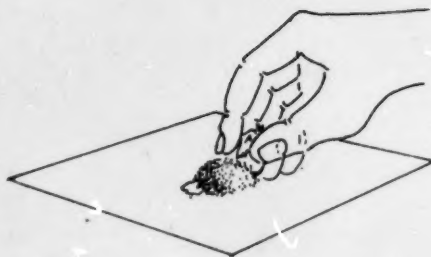
Follow the flow chart to make your flaming ball.



1. Tear off two small corners of foil. You will need these later.



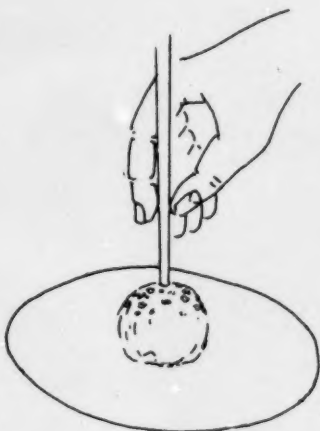
2. Put the potassium nitrate, the sulphur and 2 spatulas ammonium dichromate onto the rest of the foil. Mix them up well with your spatula.



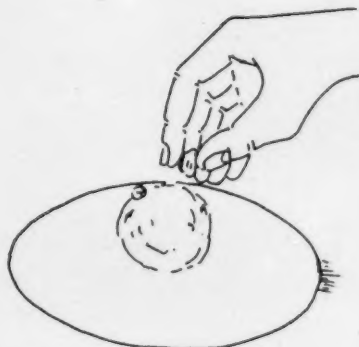
3. Fold up your half piece of filter paper and put it on the top of the mixture.



4. Wrap up the parcel to make a ball, making sure it is tightly closed. Turn the ball over and put it on the large piece of filter paper.



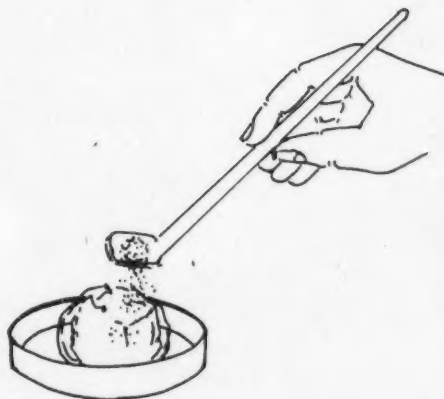
5. Make holes all over the top of the ball with your stirrer end.



6. Break off the heads of 4 matches. Wrap 2 match heads in each small corner of foil. Put the 2 small parcels on top of the large ball of foil.



7. Fold over the filter paper to make a big ball, wrapping the steel wool closely around it to hold it in place.



8. Put the ball into your evaporating dish. Sprinkle the last spatula full of ammonium dichromate over the whole ball.

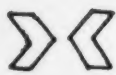
9. GO OUTSIDE WITH YOUR DISH, BOX OF MATCHES AND BURNER STAND.
10. Pour 5ml methylated spirits over the ball. Put the dish on the stand and set the ball on fire using a match.
11. Watch what happens!

Did you enjoy that? The burning ball of gas and dust which became the earth must have been a wonderful sight! Unlike your ball, it cooled very slowly, because it was so big.

Probably the ball which was the beginning of our planet was even bigger than the earth as we know it today. It was surrounded by gases, with an inside of hot, liquid rock. We call such rock **MOLTEN** (that is, melted) rock.

Quite soon, the outside gases diffused away. A cooler, thicker **CRUST** (or skin) began to form on the outside of the ball. This had cracks in it, through which gases came shooting out. It was these which formed the beginning of the gases around us. We call the gases surrounding the earth our **ATMOSPHERE**. In early times, the atmosphere was not quite the same as it is now. You would not have been able to breathe, because there was no **OXYGEN**! This came much later. There was plenty of water, but the heat turned the water into steam.

Let us summarise what we have learnt about the earth so far:

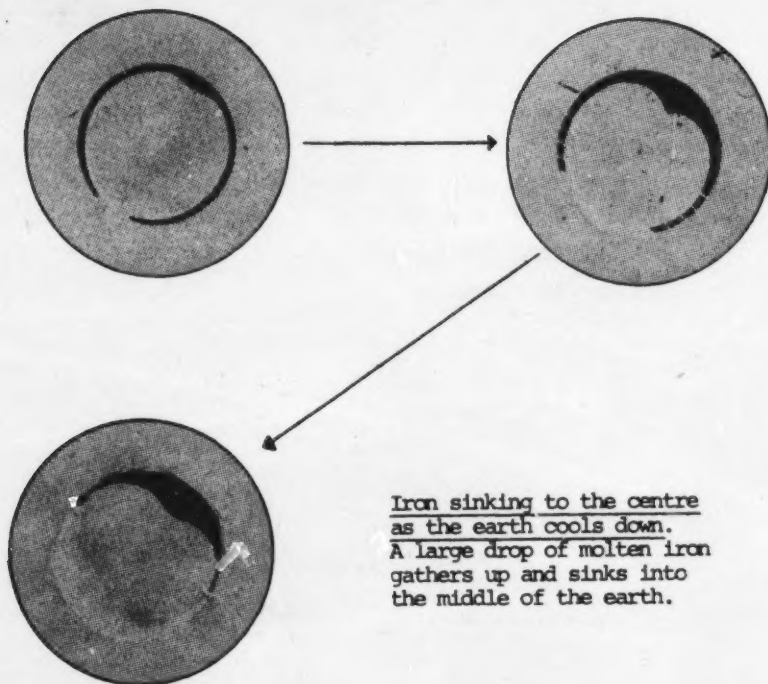
- 
1. A fiery ball of gas and dust started to cool.
 2. Some of the cooling cloud formed the planets.
 3. Our planet 'Earth' formed, with an inside of molten rock and a cooler outside crust. Gases coming out through the crust started to form the atmosphere.

The earth was a very unpleasant place in those days!
No living things could possibly have made a home there.
The surface was red-hot rock and the atmosphere was full
of steam, gases and thick dust.



The surface of the earth in early times

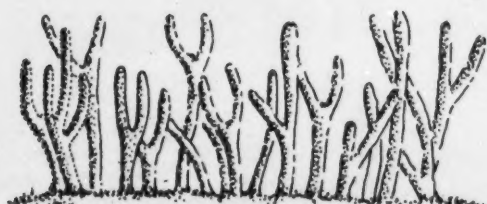
Slowly, however, the outside crust became more
thick and solid. Lighter rocks rose to the surface
while heavier ones sank in towards the centre.
For example, iron (which is heavy) sank to the centre
of the earth at the beginning of the cooling.



Iron sinking to the centre
as the earth cools down.
A large drop of molten iron
gathers up and sinks into
the middle of the earth.

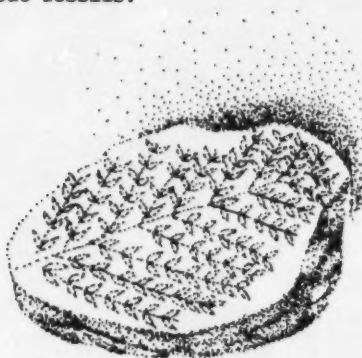
The very light rocks floated on the surface of the crust and began to form LAND. Water began to condense on the cooling crust to form SEA. Once the water was there, the first living cells could grow. These first living things were simple plants, like the green algae which grow at the bottom of a pond.

Your teacher will give you the biostrip you looked at in Unit A2. On the strip is a slide of some algae. This is how the very first plants looked. Bigger plants developed slowly as time went on.



Some early plants

How do we know about these plants - the very first life on Earth? Once again, we have to look for clues to help us, and we are lucky that we have some very good clues about this. The clues that tell us about living things are called FOSSILS. Listen to your teacher now as he tells you about fossils.



A fossilised leaf

A sketch of the surface of the earth at the time of the plants which formed our COAL



Where do we find the oldest fossils in the world? Right here in Zimbabwe! GEOLOGISTS (people who study the earth) have discovered the remains of blue-green algae that lived in the Belingwe area about three thousand million years ago! So we know that there were plants on earth as long ago as that.



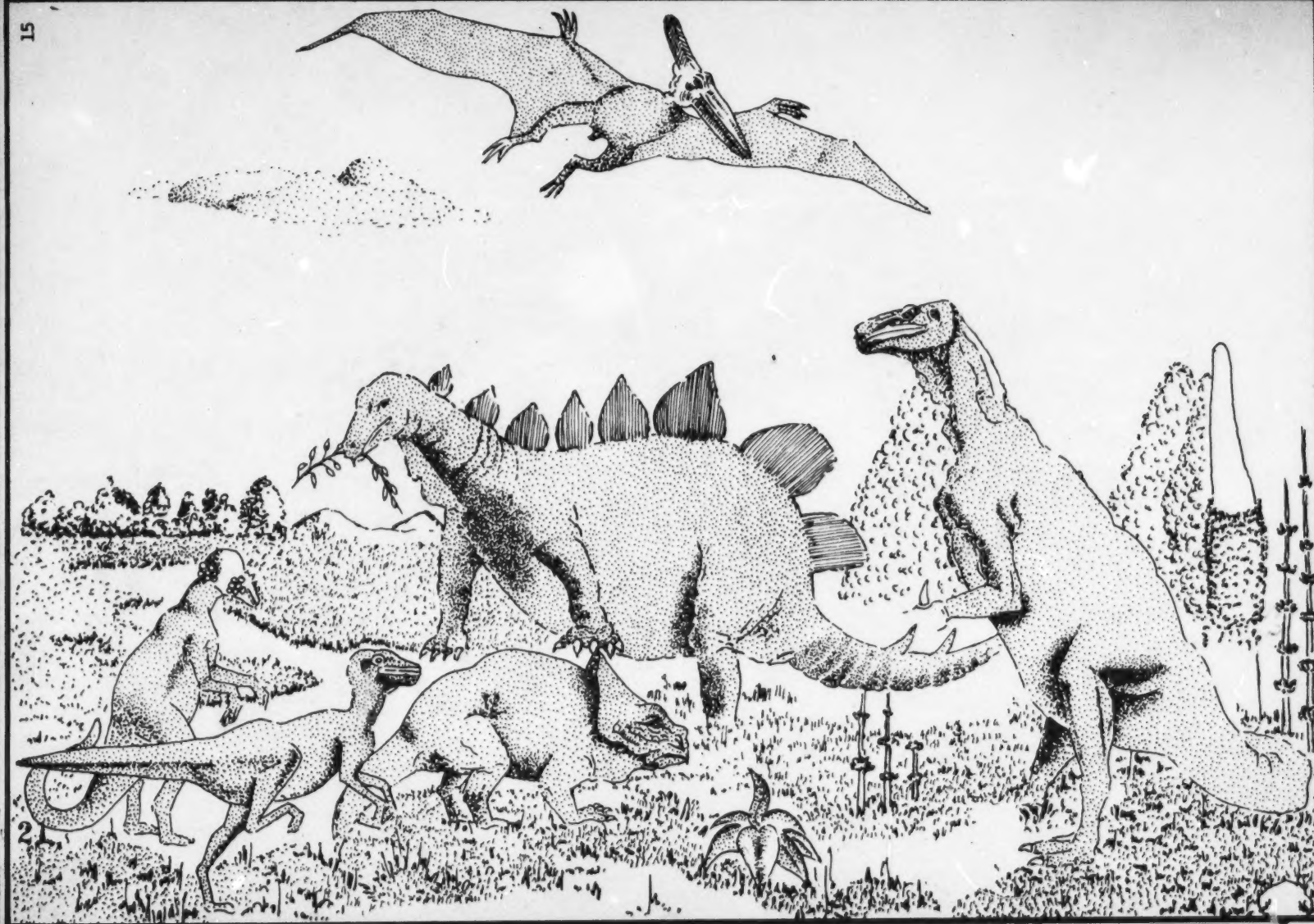
These fossil algae are very small and difficult to see clearly. Fossilised leaves or small animals are much easier to identify.

As the plants developed, the earth continued to cool down. Large areas of land formed CONTINENTS, with seas all around them. There were changes in temperature, from very hot to very, very cold.

The continents which formed first were not the same as those that exist today. It is thought that South America, Africa, Antarctica and Australia were once all joined together as shown below to make a big "supercontinent!"



In the middle of all this activity, animal life began. The first land animals were not like those we see today! Look at the picture of some of these early animals. They look very fierce, don't they? When all those animals wandered about the earth, there were no men to see them. Once again we have to use fossil clues to tell us what they looked like.



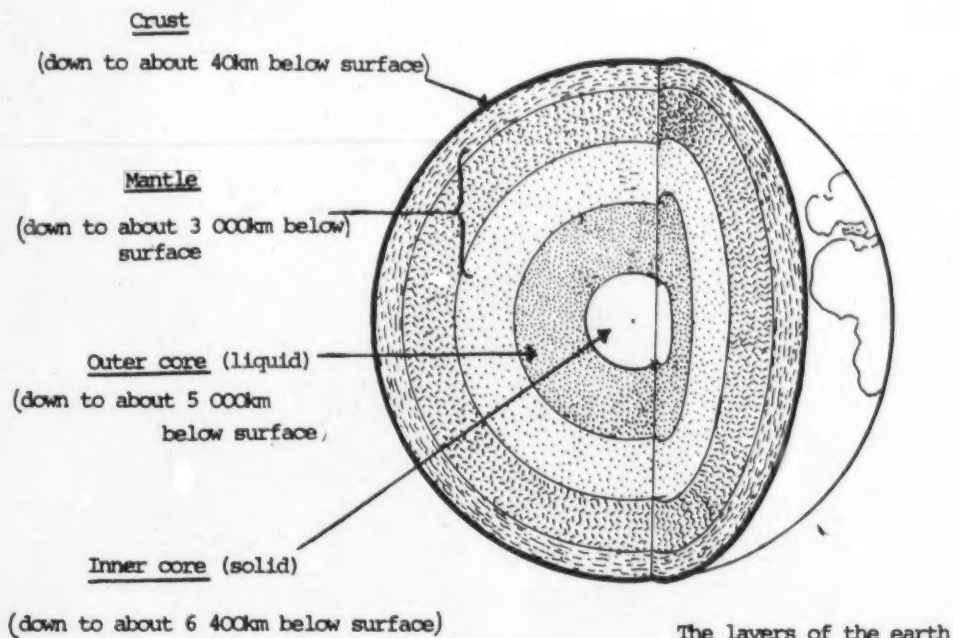
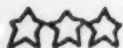
When did man appear on earth? As near as we can estimate, it was not very long ago compared with the age of the earth. We think man appeared about one million years ago. The age of the earth is at least 4600 million years, since the dusty cloud of gases first started to cool! By the time the first man appeared, most of the earth's crust had settled down and looked more or less as it does today.



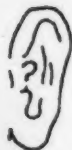
Early Man.

The first men were hunters. Slowly they developed tools to help them in their daily activities. Man has changed a lot since these early times!

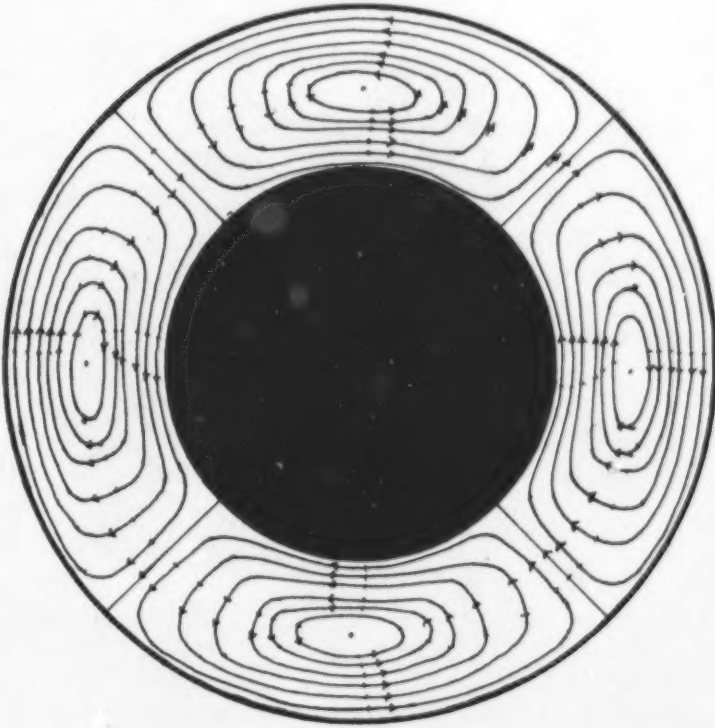
We have discussed the cooling down of the earth's crust - but what was happening to the inside? It cooled too - but not completely. We now believe that the earth's inside is a number of layers like this:



The 'core' is the innermost part, which is thought to be mainly iron at a very high temperature. It is strange to imagine a solid middle made mostly of iron which is at a much hotter temperature than the melting point of iron. Why do you think it is solid and not liquid? Discuss this with your teacher.



The mantle is not solid and is not as hot as the core. It is a thick liquid, which can move slowly as CONVECTION CURRENTS are made. The molten rock which is found there is very heavy. It is darker in colour than the rocks which form the crust. Because of this, we believe that the rock making up the mantle is not the same as those we find nearer the surface. The mantle is more dense.

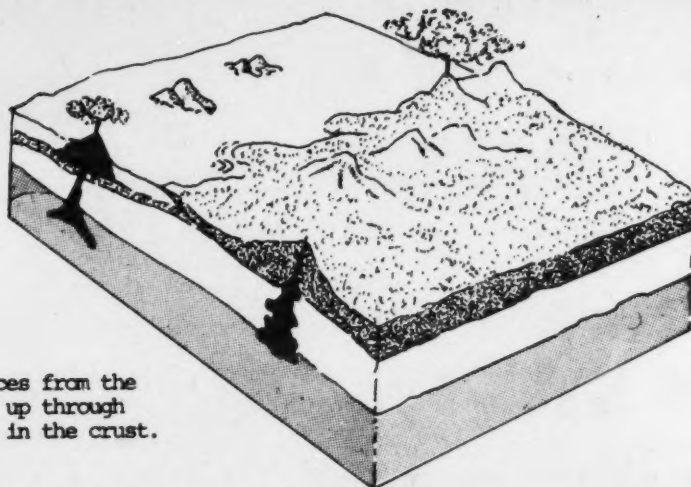


Simple picture of convection currents in the mantle
In fact the actual currents are not as regular as this. This is just an idea of how the convection currents work.

We have never been able to dig down deep enough to get through the earth's crust into the mantle. The deepest mine in the world is the Western Deep Levels Mine (a gold mine). This is in the Republic of South Africa and is 3 840m deep, compared to the crust's depth of 35Km under the land. At the bottom of this mine the temperature may be as high as 55°C . The pressure is very great at this depth.

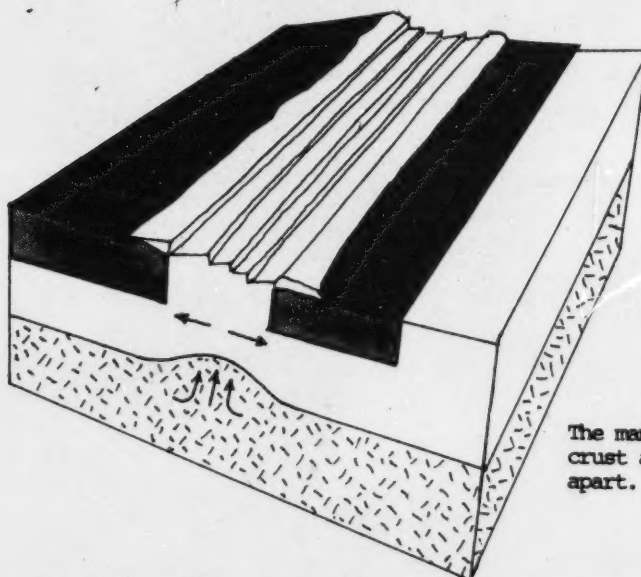
Man's deepest 'hole' in the crust is in the United States of America. The hole is drilled under a gas well in Oklahoma County. It is 9 583m deep and took about 500 days to drill. The temperature at the bottom of the hole is about 250°C .

In 1961 the Americans tried to drill a hole through the earth's crust under the sea at a place in the Pacific Ocean where the crust was only about 5Km thick. Unfortunately the experiment became very expensive and was stopped before they reached the mantle.



Hot substances from the mantle rise up through weak places in the crust.

There is activity all the time at the places where the crust and the mantle join together. Sometimes this activity results in a volcano ERUPTING, that is, spitting out fire and gases and molten rocks which come from the mantle. Also, did you know that the floor of the sea is moving all the time? New rocks rise up from the mantle underneath. Even the continents are moving slowly, as the mantle below pushes up the crust.



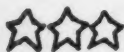
The mantle pushes up the crust and forces it apart.

Sometimes parts of the crust are pulled down into the mantle. The rocks of the crust then melt at a great depth. Being less dense than the mantle rocks, these molten rocks from the crust rise up again, making islands in the sea and making mountains on the land.

Now you can spend some time thinking and talking about all that is happening deep down underneath your feet. Remember it is hotter than the biggest fire you can ever imagine! After your discussion do Exercise 2.



Now that you know more about the earth's structure, and how it all began, you can look at some rocks which come from the earth's crust. There are many different kinds of rock in the earth's crust but they can be divided into three main groups. They are called IGNEOUS, SEDIMENTARY and METAMORPHIC. These are difficult names, but I'm sure you will be able to remember them!



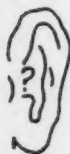
What do the names mean? Let us start with the oldest ones - the igneous rocks. These are rocks which have been molten at some time long ago but are now solid. Often, igneous rocks are made up of several different kinds of crystals. Geologists call these crystals MINERALS.

If igneous rocks are broken up by wind, rain and ice, the pieces may be carried away by rivers and end up as mud or sand at the bottom of the sea. This mud gets squashed up and the water is squeezed out by more mud settling on top. The squashed mud forms a hard layer of rocks. These are then our second kind of rock called sedimentary. Some sedimentary rocks can be formed by chemical reactions in the water.

The last group (metamorphic rocks) are formed when igneous or sedimentary rocks are changed by the action of heat or pressure. Often this happens deep underground. The chemical behaviour of the rock stays the same. The only change is a different arrangement of the particles.

In the next experiment, you are going to look at two different igneous rocks. Although both these rocks are found in Zimbabwe which is part of the earth's crust, one sample is very like rock from the earth's mantle. It is darker in colour and more dense than the other.

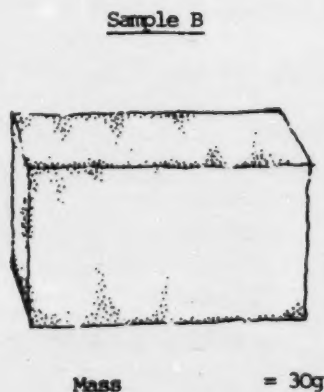
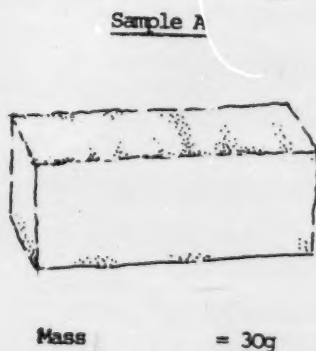
Before you do the experiment, you should think about the word DENSE. We have said before that this word describes rocks which are heavy. How can you measure this heaviness, or DENSITY? Of course, you can find the mass of two different rock samples, but if one sample is large and the other is small, your measurement will tell you nothing. How can you get round this problem? Discuss your ideas with your teacher.



You will see that you need to take samples of the same size to compare their densities. This is not easy to do with rocks because their shapes are not regular. You will have to measure their volumes by displacement of water, as you learned in Unit A1.

Let us take an example of this to make the idea quite clear.

Suppose we take a piece of rock (sample A) and we find its mass. Then we displace some water to find its volume. We do the same for another rock (sample B). Here are our results:

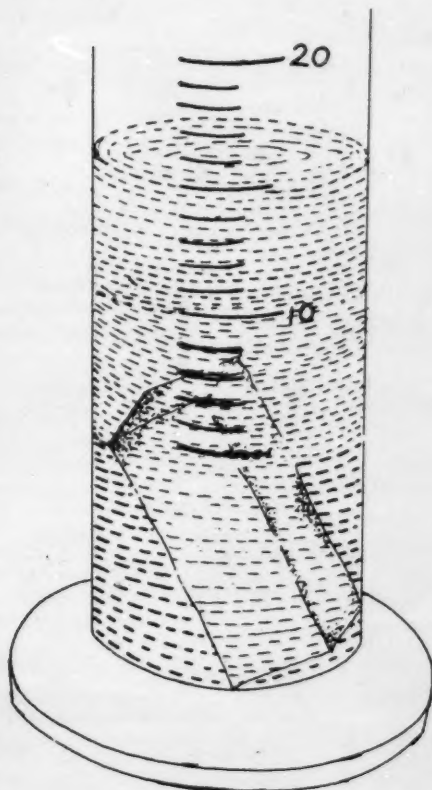


Sample A

Volume of water displaced = 10cm^3

Therefore:

Volume of sample = 10cm^3



Therefore:

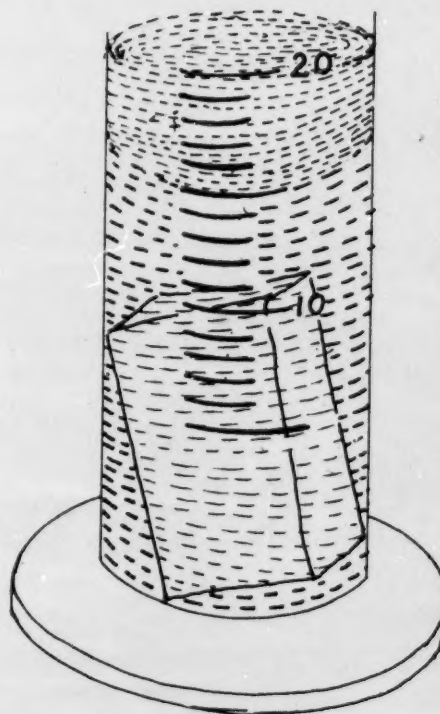
1cm^3 of Sample A has a mass of 3g.

Sample B

Volume of water displaced = 15cm^3

Therefore:

Volume of sample = 15cm^3



Therefore:

1cm^3 of sample B has a mass of 2g.



Therefore:

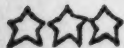
A is ~~more~~ DENSE than B

because 1cm^3 of A has a bigger mass than 1cm^3 of B.

Now we can define DENSITY.

Definition:

The density of a substance is the mass of one unit of volume of that substance.



Now that you know how to measure density you can go on to Experiment 2.

EXPERIMENT 2 : Looking at igneous rocks

You will need, for the first part of the experiment:

handlens

2 different igneous rocks commonly found in Zimbabwe.

1. Look at the samples of DOLERITE and GRANITE with your handlens. These are both igneous rocks. You will be able to see areas which are differently coloured. Each of these areas is a different mineral. How many different minerals can you see in these samples? Are they the same in the dolerite as they are in the granite? One of these looks like a mantle rock and the other a rock from the continental crust. Try to guess which one is the mantle-like rock. Answer Exercise 3.
2. Rocks from the mantle are more dense than rocks from the crust. You can determine which is the denser of your two samples now. For this part of the experiment you will have to work in larger groups. Follow the instructions carefully, recording your results as shown in Exercise 4.

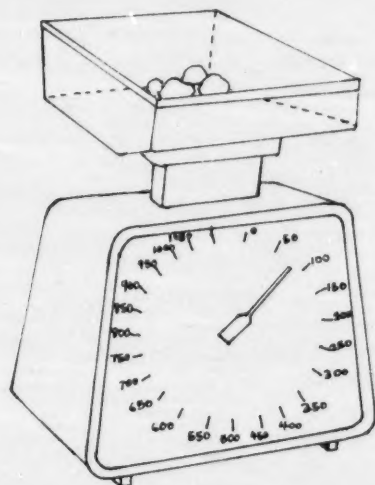


Your teacher will give you:

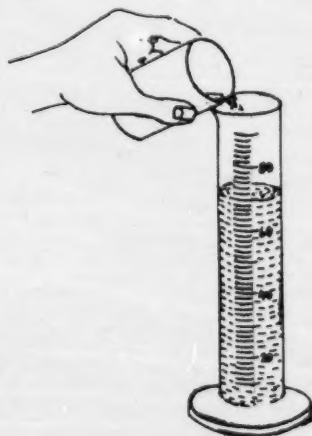
dropper

balance (check that it reads zero before you begin!)

measuring cylinder

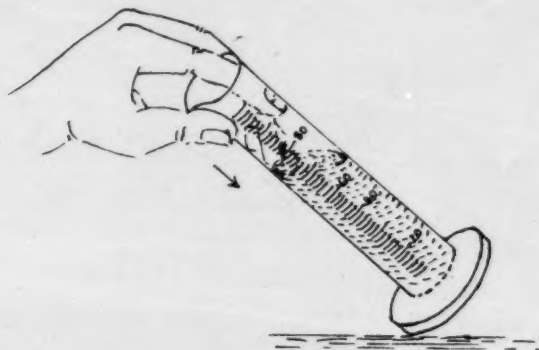


1. Start with the DOLERITE. Place enough rock pieces on the balance to give a mass of about 65–75g. Record the exact mass that you have. Do not go higher than 75g. Try to read the balance to half a division (nearest $2\frac{1}{2}$ g).



2. Put water into the measuring cylinder exactly to the 70cm^3 mark. Use a dropper if you have difficulty in adjusting the water level.

3. Drop the rock samples into the water CAREFULLY WITHOUT SPLASHING. They should NOT stick up out of the water. All the rock pieces must be under the water. Measure the new volume as accurately as you can.



Try to read the scale to the nearest half a division.

4. Repeat the whole process using the GRANITE pieces.

Now answer Exercise 4.



Were your results as you expected? Did you guess the mantle-like rock correctly? Well done!

What can you see when you look at sedimentary and metamorphic rocks! You can expect to see separate crystals in sedimentary rocks, because they have been formed by a mixture being squashed together. Do Experiment 3 now.

EXPERIMENT 3 : Looking at sedimentary and metamorphic rocks of the same substance

You will need:

burner and stand
handlens
water
evaporating dish
5ml measure

Your teacher will give you:

balance
measuring cylinder
hydrochloric acid
1 sedimentary rock)
1 metamorphic rock) commonly found in Zimbabwe

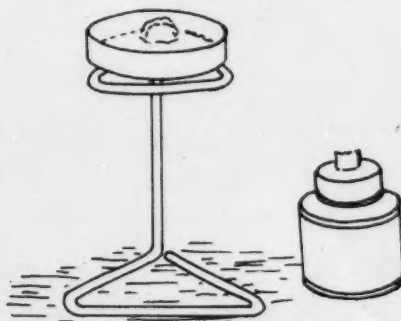


1. Observe your samples of LIMESTONE and MARBLE using your handlens. How many minerals can you see this time? What is the difference between the samples? A metamorphic rock is often made of well-formed single crystals. Which one do you think is the metamorphic rock?
2. If one rock is a metamorphic form of the other rock they should give the same chemical reactions and should have the same density. You can try this now:



- (a) Put 5ml hydrochloric acid into your evaporating dish. Be careful never to touch the acid! It will burn your skin.

Heat the acid on the burner. When the acid starts to bubble, blow out your burner.



Place the piece of MARBLE in the hot acid. What do you see? Now remove the marble and quickly wash off the acid (don't get any acid on yourself!) Put the limestone into the hot acid. What do you see now?

Do not leave the limestone in the acid for very long. Take it out and wash it well.

- (b) Carry out a density measurement on the limestone and the marble exactly as you did in Experiment 2 for the dolerite and the granite.

Now answer Exercise 5.

Now that you have discovered more about your rocks, can you set out their characteristics in the form of a key?

Next time you are climbing a hill near your school, bring back a clean piece of rock. Perhaps you can fit its characteristics to those on your key. If you can't, please remember that we have looked at just four Zimbabwean rocks. There are, of course, many more!

ACTIVITY 2

Your teacher will give you a bioset and bioviewer. To end the first part of this Unit, you can now examine a bioset about rocks. Read the bioset first then read the additional information below.

You will see that Slide 1 looks very like the granite that you examined in Experiment 2. In Slide 2, this granite has been cut to get a very thin piece. Light can shine right through it. Geologists often examine rock specimens in this way. They call it a THIN SECTION.

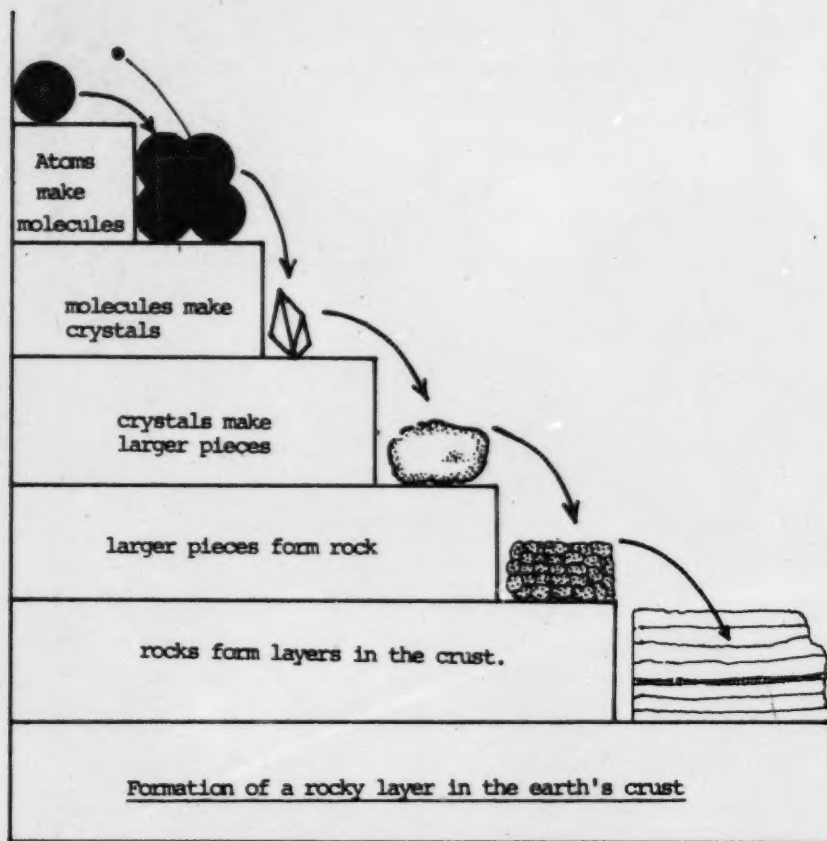
Did you see any of the minerals mentioned in the bioset when you looked at your own granite specimen? Probably you saw some QUARTZ.

Slide 6 shows a fossil leaf. You can find leaves like this in Zimbabwe. From your knowledge of coal areas, where do you think you might find fossil leaves?

Slide 7. In Zimbabwe, we usually find limestone with plant fossils in it. We have already mentioned that some of these fossils are the oldest in the world! We do not usually find snails. However, snail fossils are very common in other parts of the world.

Slide 8. You will be able to compare the marble in this slide with the limestone in Slide 7. Do they look like your samples?

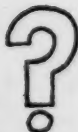




Before you complete 'How much do you know?' read and revise the whole of Part 1 of this Unit. Spend a whole lesson on revision.

HOW MUCH DO YOU KNOW?

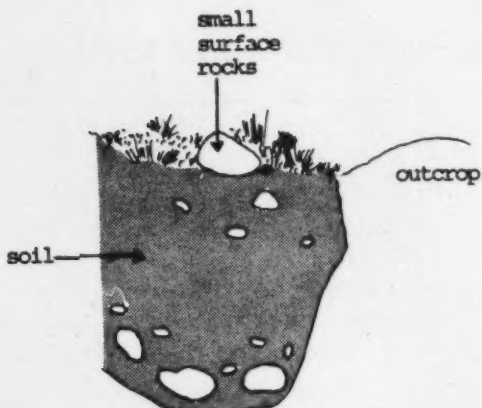
1. Briefly describe the formation of the earth.
2. Draw the earth's layers and label them.
3. Name the three kinds of rocks. Can you explain the differences between them?
4. How would you tell a mantle rock from a crust rock?
5. What chemical test would show that limestone and marble are the same substance?



PART 2

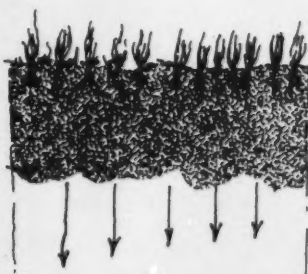
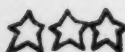
HOW DOES SOIL FORM?

Most of the surface of the land is covered by a layer of soil. In places, it may be as thick as several metres. Without the soil, most plants could not grow. The soil is therefore very important!



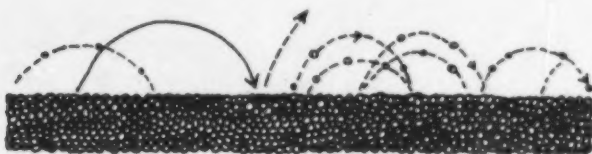
Soil resting on a layer of rock

Soil forms when rocks are broken into small pieces. Breaking up rocks to form soil is called WEATHERING. Rocks may be broken up by chemical reactions, for example between the rainwater and the rocks. This is called CHEMICAL WEATHERING.



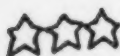
Rain falls on rocks and dissolves their surface molecules. Gradually the rocks are broken up and the chemicals wash down into the crust as the rainwater carries them away.

Sometimes the wind blows small pieces of rock against other softer rocks and rubs them away to dust.



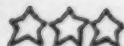
Small rock particles weathering a soft surface

Rain, ice and rivers can cause rocks to break up too by rubbing away the surface of rock, little by little. These ways of breaking up rocks are called MECHANICAL WEATHERING. Changes in temperature between day and night, sunshine and rain, cause rocks to crack and speed up mechanical weathering.



There are many things which decide the kind of soil that will be formed in a certain place. For example, the amount of rainfall will make the soil dry or moist. In very wet areas the soil will be moist to quite a depth. Moisture helps chemical reactions to take place. If it is very hot, chemical reactions will also be more likely. Climate is therefore important!

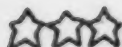
Sometimes small pieces of rock may be carried by wind, rain, rivers or moving ice to other places. Usually, however, the soil on the surface is a good clue to the kind of rock that lies under the surface. Dark coloured soils come from dark coloured rocks while light coloured soils come from pale red, grey or yellow rocks.



Soils are grouped according to their characteristics.

A soil which holds a lot of water is called a CLAY.

Clays are made of very small pieces of rock and are usually formed by chemical weathering. The reason for this is that the rocks that form clays react easily, to give products made up of very, very fine pieces stuck together. An example of a rock which usually forms a clay is dolerite. BASALT is another clay-forming rock: it is very like dolerite but with much smaller pieces. Both dolerite and basalt are mantle-type rocks.

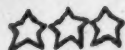


A soil which holds very little water is called a SAND. Sandy soils may have large or small pieces of rock. We call them GRAINS. If the grains are very small, it is said to be a FINE SAND. If they are large, it is a COARSE SAND.

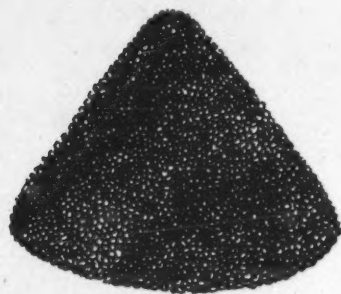
Mechanical weathering results in sand. Rocks which are not easily attacked chemically will have mechanical weathering as the main way in which they are broken up. An example of such a rock is granite.



Of course, there are many soils which are a mixture of clay and sand. Their characteristics are in between those of a clay and those of a sand. If it is half and half, it is called a LOAM.

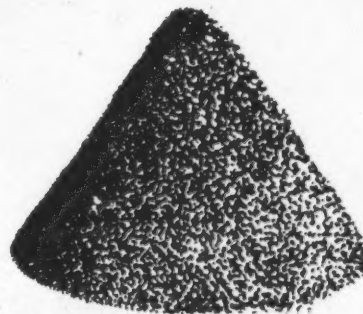


When small plants and animals die, their bodies rot in the soil and form a substance called HUMUS. This humus mixes with rock pieces to make soil in which plants can grow well.



Sand

Separate pieces
which may be
coarse or fine



Clay

Very small
pieces stuck
together



Humus

Rotting plants
and small animals
(similar to
COMPOST)

In the next few experiments you will be finding out what kind of soil you have in your area. After you have completed them, you will be able to decide whether you have good, fertile soil or not!

Before you begin the experiments, and to make sure you understand what you have learnt about soils so far, answer

Exercise 6.



What kind of soil do you have?

The next few experiments will be carried out on the soil you find in your area. Go outside with your boiling tin and collect a tin full of soil. Your teacher will help you to choose a good place to collect it.

EXPERIMENT 4 : Looking at soil

You will need:

soil
spatula
plastic cup and lid
water
handlens
2ml measure



Put 1 spatula soil onto the white plastic lid and spread it out. Look at the colour of the soil. What else can you see? Perhaps you can see some large, hard pieces. These are the pieces of rock we talked about earlier. Can you see any roots, or dead leaves? This is some of the humus. Use your handlens to study the soil. Use a 2ml measure of water to make the soil wet. What colour is it now?

Tip all the soil from your lid into the plastic cup. Add 2 more spatulas soil. Now pour water into the plastic cup CAREFULLY until it is about half full. Do not stir. Observe the surface of the water. Can you see anything rising from the soil?

Now stir with your stirrer and leave to settle for about one minute. Can you see anything floating on the water?

Answer Exercise 7 now.



EXPERIMENT 5 : Feeling soil with your fingers

You will need:

2 ml measure
soil
water
evaporating dish



1. Take a pinch of soil between finger and thumb.
2. Pour 2ml water slowly through your fingers.
3. Rub wet soil between finger and thumb as you pour.
4. Observe result.
5. Wash clean with further 2ml lots of water.

You might have observed some of the following:

1. Soil felt stony and you could feel many separate pieces. Soil washed off easily and did not dirty the fingers very much. (Characteristic of a SAND).

OR

2. Soil felt soft and slippery. Soil became stiff and made a hard ball when you rubbed it. It was hard to wash off and dirtied the fingers. (Characteristic of a CLAY).

OR

3. Soil felt stony but there was quite a lot of mud. The soil stuck together quite well but did not make a ball. It dirtied the fingers but was not very hard to wash off. (Characteristic of a LOAM).

Are you starting to decide what kind of soil you have?
Carry on with your experiments!

Perhaps you were not able to observe very much when you looked at your soil with your handlens. This might be because there are many very, very small pieces of rock. If it is a true clay, the pieces would be very small indeed. You can find out more about this now.

EXPERIMENT 6 : Finding out more about which type
of soil you have

You will need:

graduated beaker
plastic cup
water
spatula-stirrer
soil
evaporating dish
burner and stand

Follow the flow chart for this experiment.

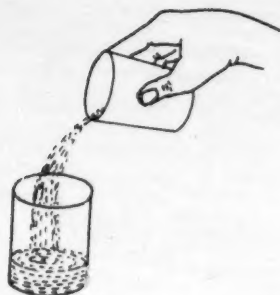
1. Put soil into graduated beaker. Press it down hard with spatula.



If you see any large leaves or roots, take them out.
Continue adding soil up to 25ml mark (half way up
the beaker).

2. Now put water into the beaker to about 40ml mark
(three quarters full). Stir with your stirrer.





Straight away pour most of the muddy water into the plastic cup. DO NOT pour out the bottom part of the mixture! Have a look at the end of your stirrer. Is there a ball of clay on it? Is the stirrer dirty?

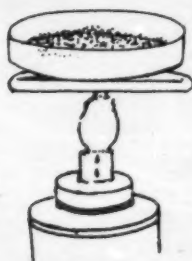


3. Repeat Step 2 five times. Put the plastic cup containing the muddy water on one side to stand for at least 24 hours. It now contains most of the CLAY part of the soil.

4. You may see that the SAND left in the beaker is still a little muddy. If so, carefully wash the sand left in the beaker until it is clean. You need not keep the wash water. Do not wash more than twenty times more.



5. Empty the SAND part into your clean EVAPORATING DISH. Heat it gently over your burner to drive off all the water.



6. Let it cool. Put it back into the dry graduated beaker. Observe the volume of the sand. Keep the sand for the next experiment. Then answer Exercise 8.



The clay part must be left undisturbed for at least one day. Then you can CAREFULLY pour off the water, leaving the wet clay in the plastic cup. You can look at this clay with your handlens. Probably you will not be able to see the very fine pieces of rock.

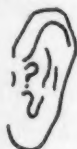
What do you see if you look at the sandy part with a handlens?
You will find out in the next experiment.

EXPERIMENT 7 : Looking at sand

You will need:

white plastic lid
 sand from Experiment 6 (which you kept in graduated
 beaker)
 handlens
 magnet

Put all the sand onto the plastic lid and look at it carefully with your handlens. Now you will probably be able to see much more than you did before! Test the sand with a magnet. What do you find? Perhaps some pieces are magnetic? Record all your observations in Exercise 9. Discuss your results with your teacher.



How well does your soil hold water? It is the water held in the soil that helps plants to grow and enables small animals to live there.

EXPERIMENT 8 : How well does your soil hold water?

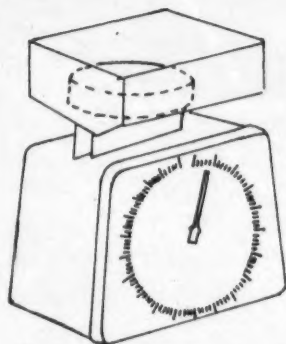
Read through this whole experiment and copy the table into your notebook before starting work. During this experiment you will find there are times when you are waiting. Use these times to write a report of the experiment in your notebook

You will need:

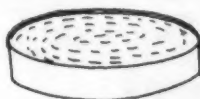
balance
 evaporating dish
 5ml measure
 soil
 water
 burner and stand
 plastic cup



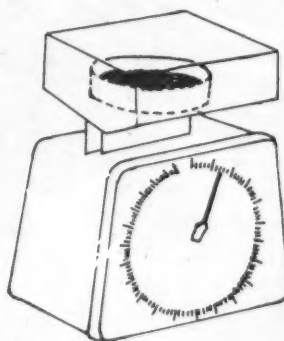
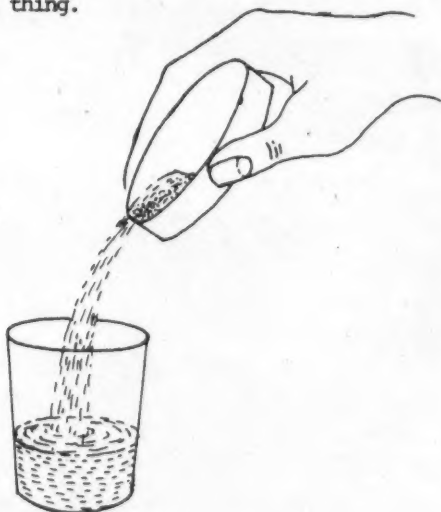
Find the mass of the evaporating dish. Then add 10ml soil.



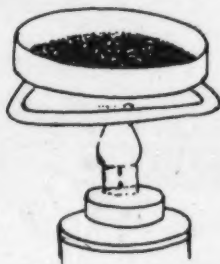
Add water until the evaporating dish is full. Allow the soil to settle by leaving it for about 5 minutes.



CAREFULLY pour off as much of the water as you can into the plastic cup, leaving the soil wet and muddy. Dry the bottom of the dish and measure the mass of the whole thing.



Now heat the soil slowly to drive off ALL the water. You will have to heat for quite a long time. Can you smell anything? What do you think the smell could be? When the water has gone away you should observe the surface of the soil as you continue to heat it.



Does it swell up? Do big cracks form as it dries? If so, it is probably a clay. After 10 minutes you should stir up the soil with a stick (NOT with your plastic stirrer - why not?) Make sure that the soil is ABSOLUTELY DRY.

Let the dish cool. Find the mass of the dish and dry soil WHEN QUITE COLD. (What would the hot dish do to the balance?).

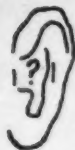
Complete your table of results (Exercise 10).

MEASUREMENT	grams
mass of evaporating dish	
mass of dish + soil + water	
mass of dish + dry soil	
therefore mass of water	
therefore mass of dry soil	

Result:

.....g soil held g water.

Therefore 1g soil held g water.



This was not a very accurate experiment. Can you think of ways to make it more accurate? Discuss this with your teacher.

In Experiment 4, you observed air bubbles coming from the soil. Air in the soil is needed if small organisms are to live there. Can you find out how much air there is in your soil?

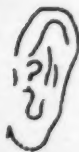


EXPERIMENT 9 : How much air is in the soil?

You will need:

water
soil
spatula
measuring cylinder

Your teacher will help you with this experiment. When you have finished, answer Exercise 11.

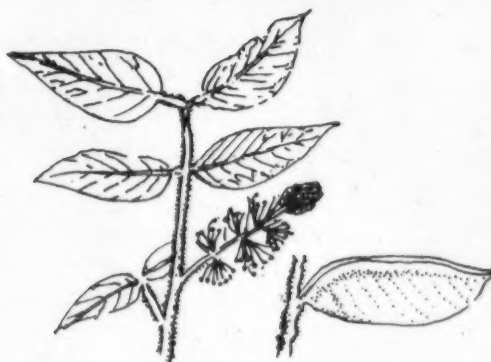


Now your teacher will discuss the kinds of trees that grow on your soil. It may surprise you to know that soil scientists often look at the kind of vegetation in an area as a guide to the kind of soil that will be found there! The pictures show some of the trees you might see to aid your discussion.

Go outside with this book. Choose a few common trees growing near your school. Compare their leaves, fruit or flowers with the pictures on the following pages. You might find that some of them match. You will then be able to name/identify the tree and the type of soil.



mnando, munhondo, umshankwe
found on highveld sand



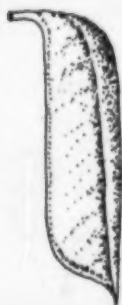
msasa, musasa, igonde
found on highveld sand



mountain acacia, munze, umbuze
found on highveld sand



mahobohobo, muzhanje, umhobohobo
found on highveld loam



mfuti, mupfuti, itshabela
found on highveld loam



acacia karroo, manga, isinga
found on highveld clay



teak, mutondo, unkusu
found on lowveld sand



baobab, mauyu, unkhomo
found on lowveld sand



fever tree, jelenja
found on lowveld clay

mopane, mupane, ipane
found on lowveld sand,
loam and clay



Now that you have investigated many characteristics of
your soil, you can try to classify it.

Copy the whole table below into your books.

55

Table 1: This table describes the characteristics of the main kinds of soils found in Zimbabwe. Make a small cross in each square that matches up with YOUR observations and results of YOUR soil.



TABLE 1

FROM EXPERIMENT 4: Rock Pieces Visible	FROM EXPERIMENT 5: Feel of Soil	FROM EXPERIMENT 6: Volume of Sand from 25ml Soil	FROM EXPERIMENT 8: Mass of Water Held by 1g Soil	DISCUSSION: Vegetation
Yes: sand or loam	many separate pieces, easily washed: SAND	15ml or more: SAND	less than 0,4g: SAND	Highveld sand
				Lowveld sand
	some separate pieces, some mud: LOAM	5 - 15ml: LOAM	0,4g - 0,8g: LOAM	Highveld loam
				Lowveld loam
No: Clay	soft and slippery, hard to wash: CLAY	less than 5ml: CLAY	more than 0,8g: CLAY	Highveld clay
				Lowveld clay

Which part has the most crosses? Have you got a sand, or loam or a clay?

Now copy down Table 2.

Table 2: This table will help you decide the kind of rock from which your soil comes.

TABLE 2

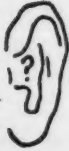
FROM EXPERIMENT 4: Colour (When Wet)	FROM EXPERIMENT 7: Magnetic pieces present in sand part
<u>Red:</u> could be dolerite <u>Black:</u> could be basalt	<u>Large amount:</u> could be mantle-type rock (e.g. dolerite or basalt)
<u>Light brown:</u> could be granite	<u>Small amount:</u> could be granite
<u>Pale red or yellow:</u> could be sedimentary rock	<u>None:</u> could be sedimentary rock

Now answer Exercise 12.

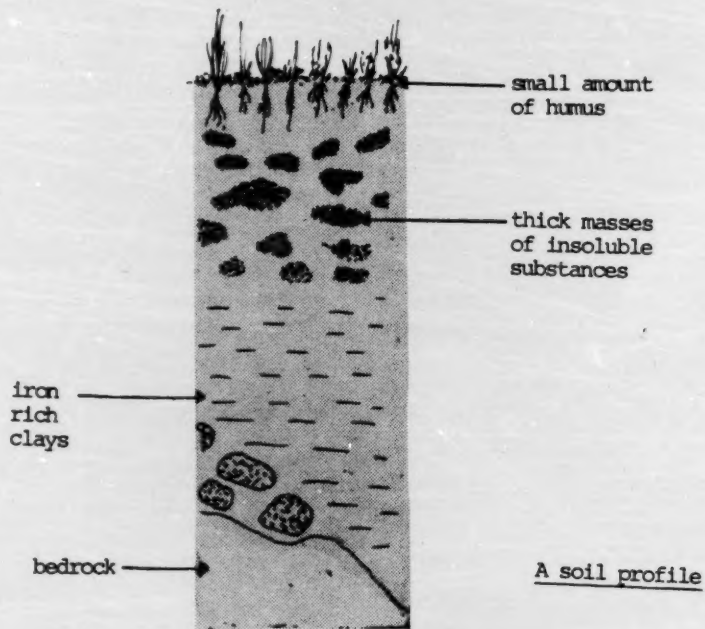
Now that you have studied the tables and described your soil type you are going to make some more observations on your soil.

ACTIVITY 3

You are going to observe outside the classroom, as a field study. Listen to your teacher as he tells you about the field study.

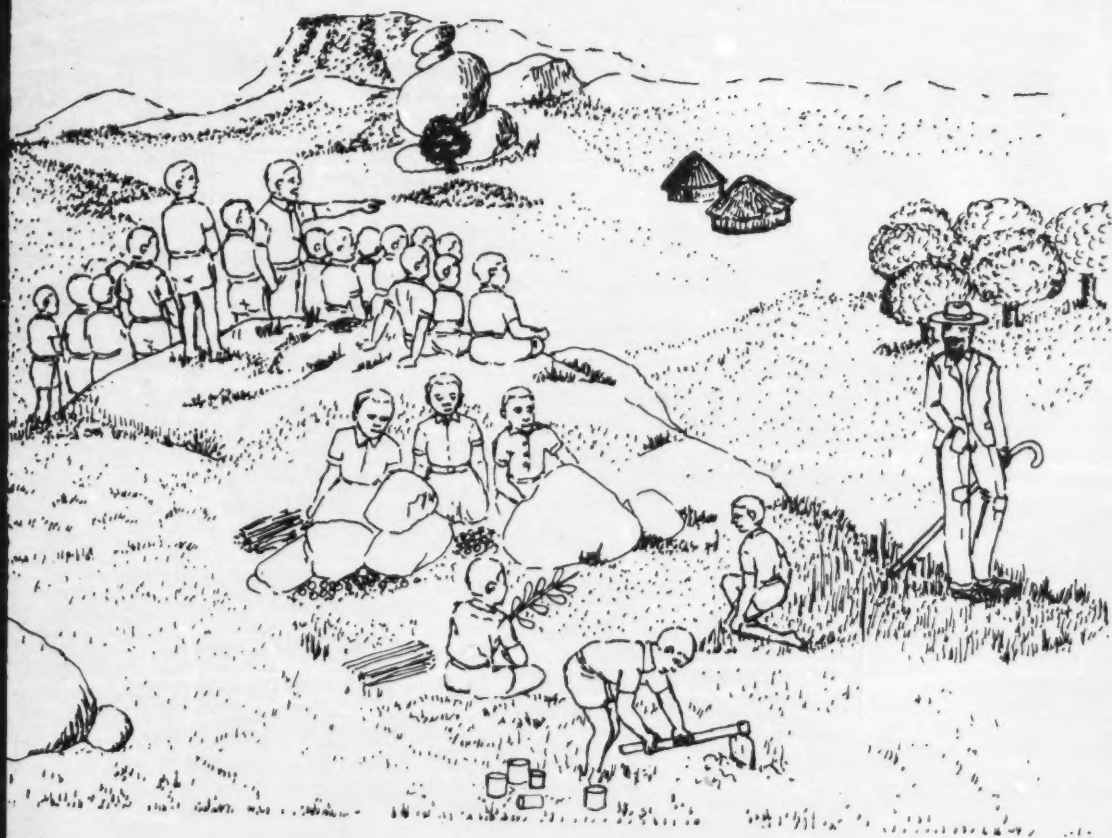


In your field study, you will observe the vegetation growing in the soil outside the classroom, you will make a plant and animal count, and you will discuss soil conservation. You learnt about soil conservation in primary school, so you should have many ideas to tell your teacher.



Come back after the field study and answer Exercise 13.





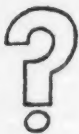
Your study of rocks and soils has taught you something about the earth and its structure. In particular you have learnt about the rocks and soils in your area of Zimbabwe. In the next Unit, you will learn more about the chemicals which make up the earth and its atmosphere. Never forget how it all began!



Before you answer "How much do you know?" read and revise Part 2 of this Unit. Spend a whole lesson on revision.

HOW MUCH DO YOU KNOW?

1. Weathering is
2. Two types of weathering are and
3. A soil made up of very small pieces which holds much water is a
4. A soil made up of larger grains which holds little water is a
5. A rock which often forms a clay is
6. A rock which often forms a sand is
7. Soil may be conserved in many different ways. List as many as you can.



SUMMARY OF UNIT F1

- 
1. The earth and the planets of the solar system were formed from a cooling cloud of gases and dust.
 2. The earth is a series of layers called the core, the mantle and the crust.
 3. There are three kinds of rock: igneous, sedimentary and metamorphic. Igneous rocks were molten in the past and then solidified. Sedimentary rocks are formed from small particles which generally join together in water. Metamorphic rocks are rocks whose structure is changed by heat or pressure.
 4. Soil is formed by weathering of rocks. Chemical weathering results in clay. Mechanical weathering results in sand. An important part of soil is humus.
 5. Soil conservation is very important for the future.